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Incentives for quick penetration of electric vehicles in five European countries: Perceptions from experts and stakeholders

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ABSTRACT

On the basis of 143 responses from experts and stakeholders from Germany, Austria, Spain, the Netherlands and the UK, we assess the perceived impact of a range of incentives for the uptake of electric vehicles (EVs). We find that the incentive that most respondents consider to have a positive impact is the development of charging infrastructure, with 75% stating so. This is followed by purchase subsidies, to narrow the difference in price of an EV and that of an internal combustion engine vehicle, with 68% of respondents stating that they have a strong or at least a partial positive impact. Pilot/trial/demonstrations of EVs, to expose potential buyers to EVs, are also perceived to have a positive effect, with 66% of respondents stating so. Tax incentives, which like purchase subsidies, narrow the gap between the total operating cost of an EV and that of a conventional vehicle, are also perceived to have a positive impact by 65% of respondents. Other incentives that are perceived to have a positive influence include climate change and air quality policies, consumer information schemes and differential taxation applied to various fuels and energy vectors.

1. Introduction

Worldwide, in 2014 road transport was responsible for 20% of total CO_2 emissions from fuel combustion (International Energy Agency, 2016). There is robust evidence which indicates a consistent relationship between cumulative CO_2 emissions and projected global temperature change to the year 2100 (Intergovernmental Panel on Climate Change, 2014, p. 8). The Paris Agreement, which came into force in November 2016, commits developed and developing countries to keeping global warming below 2 °C and aspiring to a target of 1.5 °C. Leaving to one side that in June 2017 President Trump announced that the US would pull out of the Paris Agreement, most Parties to the United Nations Framework Convention on Climate Change have ratified the Agreement and intend to deliver their National Determined Contributions (NDCs), which are reductions in greenhouse gas emissions that the different countries have committed to.

The substantial emission reductions required to achieve these targets require a decarbonisation of transport. Momentum is building and in July 2017 both France and the UK made important announcements. The French government announced that it will end 'the sale of cars emitting greenhouse gases by 2040' (République Française: Le Ministère de la Transition Écologique et Solidaire, 2017, p. 6, fourth paragraph) and the British government announced that it 'will end the sale of all new conventional petrol and diesel cars and vans by 2040' (UK Department for Environment, Food & Rural Affairs and Department for Transport, 2017, p. 1, point 6).[1]

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[1] In addition, also in July 2017, Volvo Cars announced that 'every Volvo it launches from 2019 will have an electric motor' (Volvo Cars, 2017).

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These bold political decisions will be more likely to deliver what they are intended to if they are accompanied with incentives that provide strong signals to car manufacturers, consumers and businesses, including fleet operators. It is clear that decarbonisation of road transport cannot be achieved with an increase in efficiency of fossil fuel propelled vehicles and therefore alternative vehicles are needed. Electric vehicles (EVs) are seen as a viable and very promising alternative (Sierzchula et al., 2014; Newbery and Strbac, 2016; Andwari et al., 2017; Hao et al., 2017; Wang et al., 2017), especially if electricity is generated in a clean manner (Helveston et al., 2015; Liu and Santos, 2015; Ajanovic and Haas, 2016; Bjerkan et al., 2016; Mersky et al., 2016; Egbue et al., 2017), although admittedly, fuel-cell vehicles running on hydrogen also offer hope (US National Research Council, 2013; Cantuarias-Villessuzanne et al., 2016; Kramer, 2017).

A number of policies and incentives to aid EV uptake are already in place in a number of countries, although it is still not clear how effective these are (Langbroek et al., 2016). In the present study we assess experts' and stakeholders' views on the current and potential influence of incentives, hypothetical or in place already, for the uptake of EVs. We do this on the basis of 143 responses we received to a detailed questionnaire,[2] which we conducted between March 2015 and July 2016. The respondents were based in Germany, Austria, Spain, the Netherlands and the UK, and they were asked to respond with their region in mind.

The incentive that most respondents thought had a positive impact was the development of charging infrastructure. This was followed by purchase subsidies, which narrow the gap between the price of an EV and that of an internal combustion engine vehicle. The other two incentives, which were also perceived to have a positive impact on EV uptake by most respondents were pilot/trial/demonstrations, to familiarise potential consumers, and tax incentives, which like purchase subsidies, narrow the gap between the total operating cost of an EV and that of a conventional vehicle.

By eliciting expert and stakeholder opinion on the impact of a range of incentives we contribute to the literature and provide clear policy recommendations. Despite our respondents coming from five different European countries and different sectors, such as the automotive industry, government, and non-profit organisations, amongst others, there seems to be agreement on a number of fronts. This indicates that any government in any country designing policy to increase EV uptake should put in place a number of specific incentives.

The contributions of this paper are three: (1) to identify the incentives for EV uptake that are perceived as having a positive impact by most experts and stakeholders; (2) to identify differences in perception across countries and sectors the experts and stakeholders come from; and (3) to provide clear policy recommendations on the basis of the opinions elicited.

The paper proceeds as follows. In Section 2 we give an overview of current EV uptake in the countries under study. In Section 3 we discuss the data and the methodology. In Section 4 we present the findings, critically discuss them and compare them with previous literature. In Section 5 we conclude and provide some policy recommendations.

2. Current EV uptake

Table 1 shows electric car registrations relative to total car registrations as percentages in the case study countries over 2013–2016. One very obvious point that stands out is the very low share of electric vehicles. Another feature that stands out is the case of the Netherlands, which has the largest share over the period in question, but at the same time, the most erratic. This is further illustrated in Fig. 1, which shows new EV registrations in the five countries in absolute numbers.

Although the case study countries have similar policies in place, albeit with some differences, the Netherlands is the country with the most extensive charging infrastructure per capita in the world (Amsterdam Roundtable Foundation in collaboration with McKinsey & Company, 2014, Exhibit 3.2, p. 32). This is not a trivial point, and as we show in Section 4, charging infrastructure is, according to our expert and stakeholder respondents, a very important condition for EV market penetration, and this may explain the larger share of electric vehicles in the Netherlands. The sharp fluctuations in EV sales in the Netherlands have mirrored changes in the company car tax, as we explain below.

ACEA (2017c) provides an overview of the incentives for buying EVs in different countries in Europe, including our five case study countries. EVs are exempt from ownership (also called circulation) tax in Germany, Austria, the Netherlands and the UK. In Spain, a number of cities have reduced the annual circulation tax for EVs. In the Netherlands and in Austria, EVs are exempt from VAT and in Spain and the UK they receive purchase subsidies. In Germany, in Summer 2016, after we had finished receiving responses to our questionnaire, the government introduced purchase subsidies as well.

In addition, in Austria, since 2016, company cars that are fully electric are exempt from the company car tax. In Germany, Spain, the Netherlands and the UK, company cars that are electric pay a reduced company car tax. In the Netherlands, these reductions have varied over the years and the substantial changes in sales that can be seen in Fig. 1 year on year are simply a response to these changes. For example, the drop in registrations of EVs, including both Plug-In Hybrid Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs), in 2014 was caused by a change that went into effect on 1 January 2014. In 2013 PHEVs and BEVs were exempt from the company car tax, but in 2014 PHEVs started to be charged a company car tax of 7%, and BEVs started to be charged a company car tax of 4% of the catalogue value. This change caused the sales that would have normally occurred in 2014 to move forward to December 2013.

The second drop in Dutch registrations that can be seen in Fig. 1 was in response to another change that took place on 1 January

[2] The questionnaire is available electronically as Supplementary Material on the journal website.

Table 1
Electric car registrations relative to total car registrations in the case study countries (%), 2013–2016.

Country	2013	2014	2015	2016
Germany	0.26	0.43	0.73	0.75
Austria	1.01	1.20	0.90	1.54
Spain	0.12	0.16	0.21	0.31
Netherlands	5.40	3.33	9.78	5.95
UK	0.17	0.62	1.02	1.30

Source: The ratios were computed on the basis of new car registrations and new EV registrations in the case study countries. New car registrations were taken from European Automobile Manufacturers Association, ACEA (2017a) (http://www.acea.be/statistics/tag/category/by-country-registrations). New EV registrations were sourced as follows: For the years 2013 and 2014 the numbers come from ACEA (2015) (http://www.acea.be/press-releases/article/electric-vehicle-registrations-2014), and include Battery Electric Vehicles + Extended-Range Electric Vehicles + Plug-In Hybrid Electric Vehicles. For the years 2015 and 2016 the numbers come from ACEA (2017b) (http://www.acea.be/press-releases/article/alternative-fuel-vehicle-registrations-1.2-in-fourth-quarter-of-2016–4.1-in), and were calculated as the sum of Battery Electric Vehicles + Plug-In Hybrid Electric Vehicles.

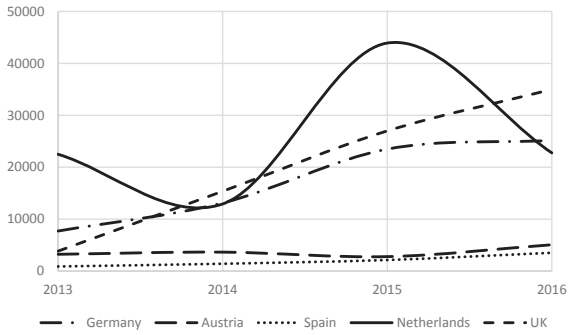


Fig. 1. New EV registrations in the case study countries, 2013–2016. Source: ACEA (2015, 2017b).

2016, when the company car tax for PHEVs was further increased to 15%. Because EV sales in the Netherlands (as in all case study countries) are dominated by PHEVs rather than BEVs, the change to the company car tax in 2016 drew a substantial decrease in PHEV purchases, in part because in the Netherlands company cars represent over 40% of new car sales (Vereniging van Nederlandse Autoleasemaatschappijen, 2016, p. 3). On 1 January 2017, the company car tax for PHEVs was further increased to 22%, but this did not cause a peak in sales of PHEVs in December 2016, as it is now too close to the standard rate of 25%.

This section has provided a brief overview of the policies in place in the five case study countries and the EV registration evolution. Looking at the past is not going to meet our obligations, however, and hence the rationale for the present study. The remaining of the paper concentrates on how experts and stakeholders in our five case study countries perceive different incentives to increase EV market penetration, with a view to identifying those that are perceived to work best for increasing EV uptake.

3. Data and methodology

The data was collected within the framework of an EU-funded project, I-CVUE (Incentives for Cleaner Vehicles in Urban Europe). A detailed questionnaire was developed based on the expertise of the project team and the steering group. This questionnaire was then sent by e-mail to around 300 experts and stakeholders in Germany, Austria, Spain, the Netherlands and the UK. The case study countries were chosen because they fell under the remit of the project and were the countries where five of the project partners were based.

Convenience sampling was used, so that the different partners could contact the different experts and stakeholders they knew already, and this was combined with snowball sampling. Potential respondents were e-mailed the questionnaire and also invited to e-mail it to other potential respondents within their organisations. The project partners that distributed questionnaires were Cardiff University, based in the UK, FIER Automotive & Mobility, based in the Netherlands, Automobil Club Assistencia, based in Spain, Robert Bosch GmbH, based in Germany, and the Austrian Energy Authority. The response rate was around 48%[3] and 143 fully completed questionnaires were received. Table 2 shows the countries where the respondents were based along with the sector they worked in at the time of taking part in the study.

[3] It is difficult to give a precise estimate of the response rate as we do not have the exact number of invitations to fill in the questionnaire that were e-mailed by our respondents to other potential respondents within their organisations.

Table 2
Respondents' country of residence and sector.

Country	Germany	Austria	Spain	Netherlands	UK	Total
Automotive industry	13	0	3	0	1	17
Fleet operators	11	0	6	2	7	26
Government (national and local, public companies and non-profit organisations)	3	7	5	9	14	38
Private companies	5	1	3	10	5	24
Experts (academics and consultants)	3	8	8	9	8	36
Anonymous[a]	1	0	0	0	1	2
Total	36	16	25	30	36	143

Source: Survey responses.
[a] Two respondents were not prepared to disclose what sector they worked in.

The questionnaire asked respondents to indicate whether an incentive had had any influence in the development of an EV market within their region. The scale respondents were presented with was Strong, Partial, Indirect, Neutral, Negative and Not applicable (N/A). For each question the respondents also had the opportunity to discuss their assessment and communicate their knowledge and opinions on the experienced (and potential) impacts from different policies. Most respondents completed this section for each question, and this yielded over 40,000 words of text to be analysed.

Table 3 describes the incentives that were considered in this study.

Table 3
Description of the incentives considered in this study.

Tax incentives	Reduction or exemption from a tax offered as an enticement to purchase an EV
Purchase subsidies	Financial contributions provided by the government to reduce the market price of an EV
Differential taxation applied to various fuels and energy vectors	Differential taxation applied to various fuels and energy vectors, such as for example petrol and electricity, to change relative prices
Consumer information schemes	Consumer information schemes aimed at providing information to potential buyers via outreach websites, individual or association blogs, specialised magazines, social network (e.g., Facebook, Twitter) groups, to name some examples
Public transport policies	Policies directed at electrifying the public transport system
Pilots/trials/demonstrations	Investments on EVs and charging infrastructure to show their feasibility and/or functionality through improved visibility
Government grants for technology development	Grants awarded for R&D of EVs and their value chain
Industrial policies	Policies that focus on and/or favour the development of manufacturing capacity directed towards EVs, such as for example, preferential treatment to EV manufacturing
Development of charging infrastructure	Development, increase, and/or improvement of a network of charging points, and/or diversification of the type of charging points (charging speed, type of sockets)
Energy generation and supply policies	Policies aimed at increasing the share of renewable energy in the energy mix and/or creating a Smart Grid
Climate change policies	Actions taken to meet CO_2 emission reduction targets.
Air quality policies	Policies aimed at reducing air pollution, such as for example, low emission zones in cities
Regional/local consumer incentives	Incentives implemented at regional or local level to influence consumers' decisions, such as for example priority road access to EVs, and free or dedicated parking

The methodological approach taken in this study was qualitative. We plotted the percentage of respondents from each of the case study countries and also the percentage of respondents from each type (automotive industry, expert, etc.) giving different assessments (Strong, Partial, etc.) to each policy considered in the questionnaire. We then conducted content analysis of the text to justify their answers and produced word clouds. Word clouds were used for visual qualitative analysis, and were ideal as more prominent words were those that appeared more frequently in the source text (McNaught and Lam, 2010, p. 630). The word cloud software that we used was NVivo 10. Individual 'Nodes' were developed for each question and country by concentrating the responses under a specific node. For example, the question on tax incentives to promote EV uptake was coded as Q1 on NVivo10. Five different nodes, one for each case study country, were then created for each of the thirteen policies/incentives under consideration. Thus, we had a total of 65 nodes. Each node gathered all the responses on each incentive by country. We then generated word clouds and also used the 'Search Text Query' to identify the most frequently used words in the text. This allowed us to establish emergent themes against specific questions.

4. Findings and discussion

Table 4 presents, for each incentive, the percentage of respondents who thought the incentive had a (strong or partial) positive effect on EV uptake. This gives an overview of how the policies were in general perceived by all 143 respondents, regardless of country of residence or sector they worked in.

Fig. 2 shows the percentage of respondents from each country (Germany, Austria, Spain, the Netherlands and the UK) that thought that each of the incentives had or had the potential to have, a strong positive impact, a partial positive impact, an indirect

Table 4
Percentage of respondents who thought the incentive had a (strong or partial) positive effect on EV uptake.

Tax incentives	0.65
Purchase subsidies	0.68
Differential taxation applied to various fuels and energy vectors	0.54
Consumer information schemes	0.59
Public transport policies	0.48
Pilots/trials/demonstrations	0.66
Government grants for technology development	0.40
Industrial policies (e.g. preferential treatment to EV manufacturing)	0.37
Development of charging infrastructure	0.75
Energy generation and supply policies	0.26
Climate change policies (e.g. aimed at reducing CO_2 emissions)	0.60
Air quality policies (e.g. low emission zones in cities)	0.56
Regional/local consumer incentives (e.g., priority road access, parking)	0.50

Source: Survey responses.

positive impact, a neutral impact, a negative impact, or that thought that there was no relationship at all (i.e., not applicable). Respondents were asked to evaluate the different incentives in relation to *their region*. Many of the incentives detailed in the questionnaire have not been implemented in all the case study countries, and this, as we discuss below, triggered many answers from respondents saying that they had an indirect, neutral or even a negative impact, and justifying their assessment by explaining that the incentive had not been introduced in their region and the *absence* of the incentive, rather than the incentive itself, had a an indirect, neutral or even a negative impact.

Combining experts and stakeholders in a common respondent group is challenging, as motivations behind their responses might differ and their perception of state of affairs might therefore differ as well. With that in mind, Fig. 3 presents the results by type of respondent (automotive industry, fleet operator, government, charities and non-governmental organisations, private companies, and academic and private consultancy experts). This allows for analysis by type of respondent rather than by country.

The most important and indeed, novel, finding is that there is a degree of similarity in the responses across countries *and* across types of respondent, except for a few cases, which we highlight and explain. This is a conclusion that cannot be statistically verified due to the small sample size and even smaller sub-sample sizes, but it is evident from Figs. 2 and 3 that the patterns are the same across the board. Most respondents thought that most incentives had a positive or at least an indirect or neutral impact. Very few respondents indicated that the incentives considered had a negative impact on EV uptake, and when they did, a detailed analysis of

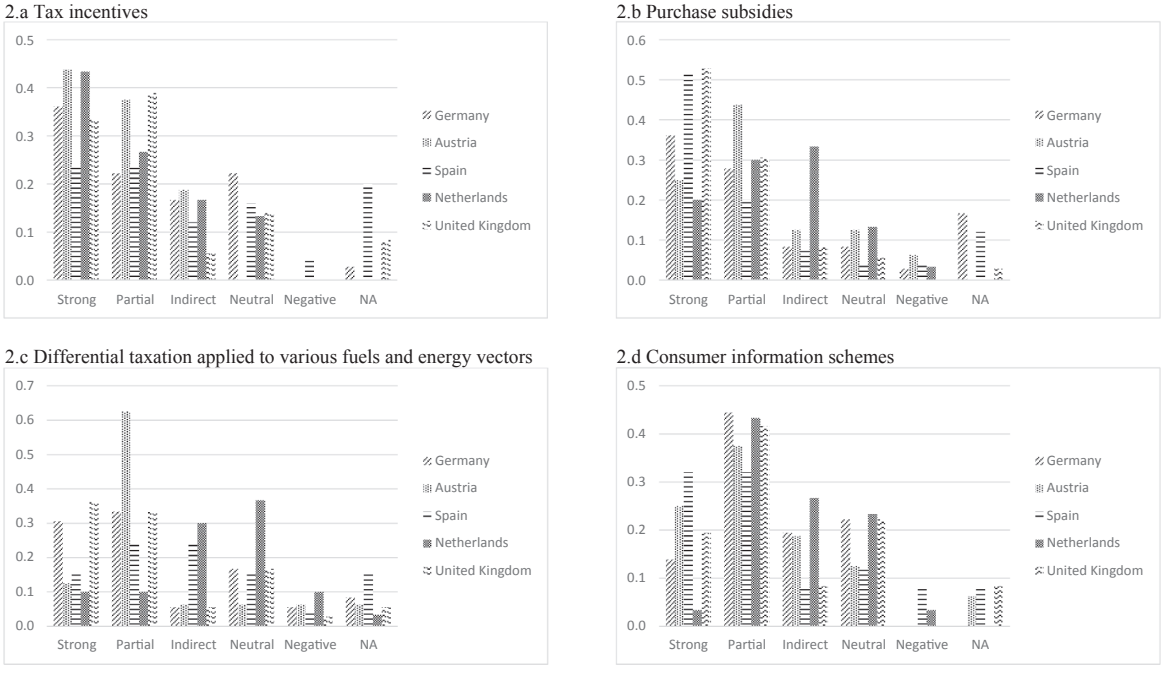
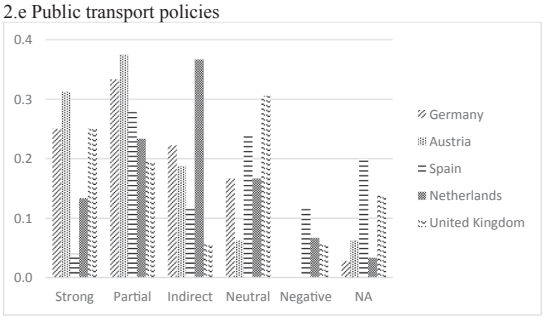
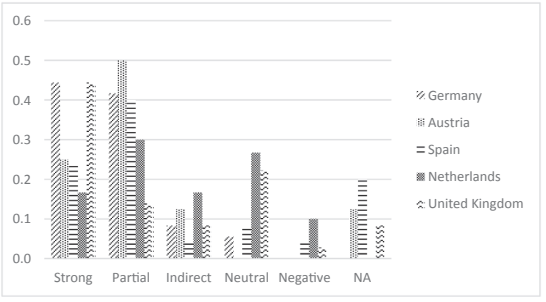


Fig. 2. Percentage of respondents by country and their assessment of each type of policy. Source: questionnaire responses.

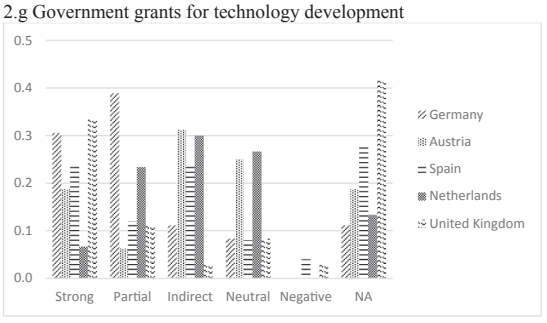
2.e Public transport policies



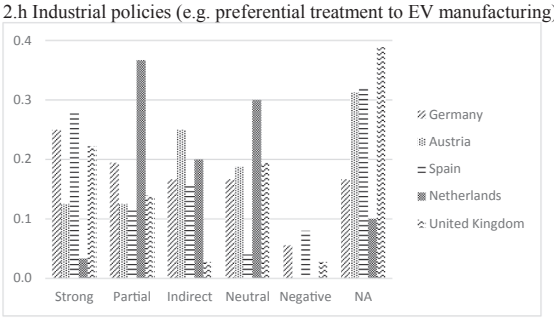
2.f Pilots/trials/demonstrations



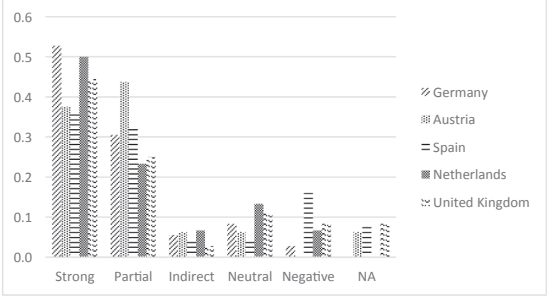
2.g Government grants for technology development



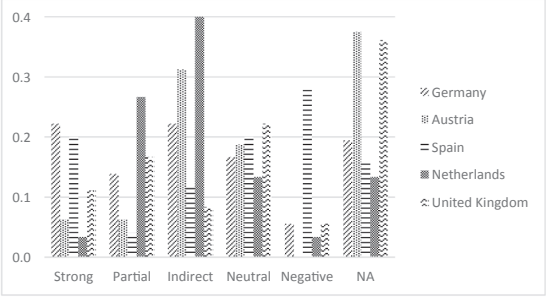
2.h Industrial policies (e.g. preferential treatment to EV manufacturing)



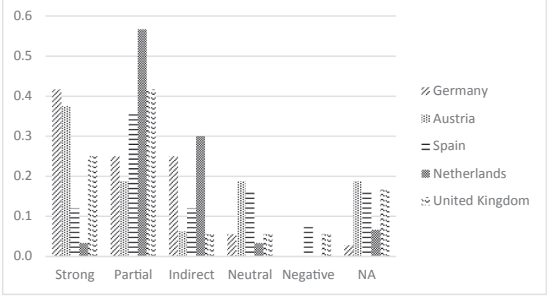
2.i Development of charging infrastructure



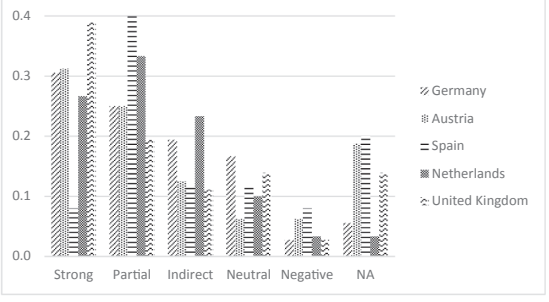
2.j Energy generation and supply policies



2.k Climate change policies (e.g. aimed at reducing CO_2 emissions)



2.l Air quality policies (e.g. low emission zones in cities)



2.m Regional/local consumer incentives (e.g. priority road access, parking)

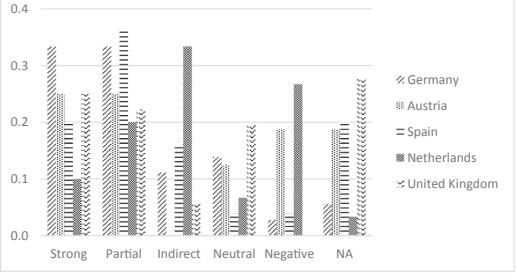


Fig. 2. (*continued*)

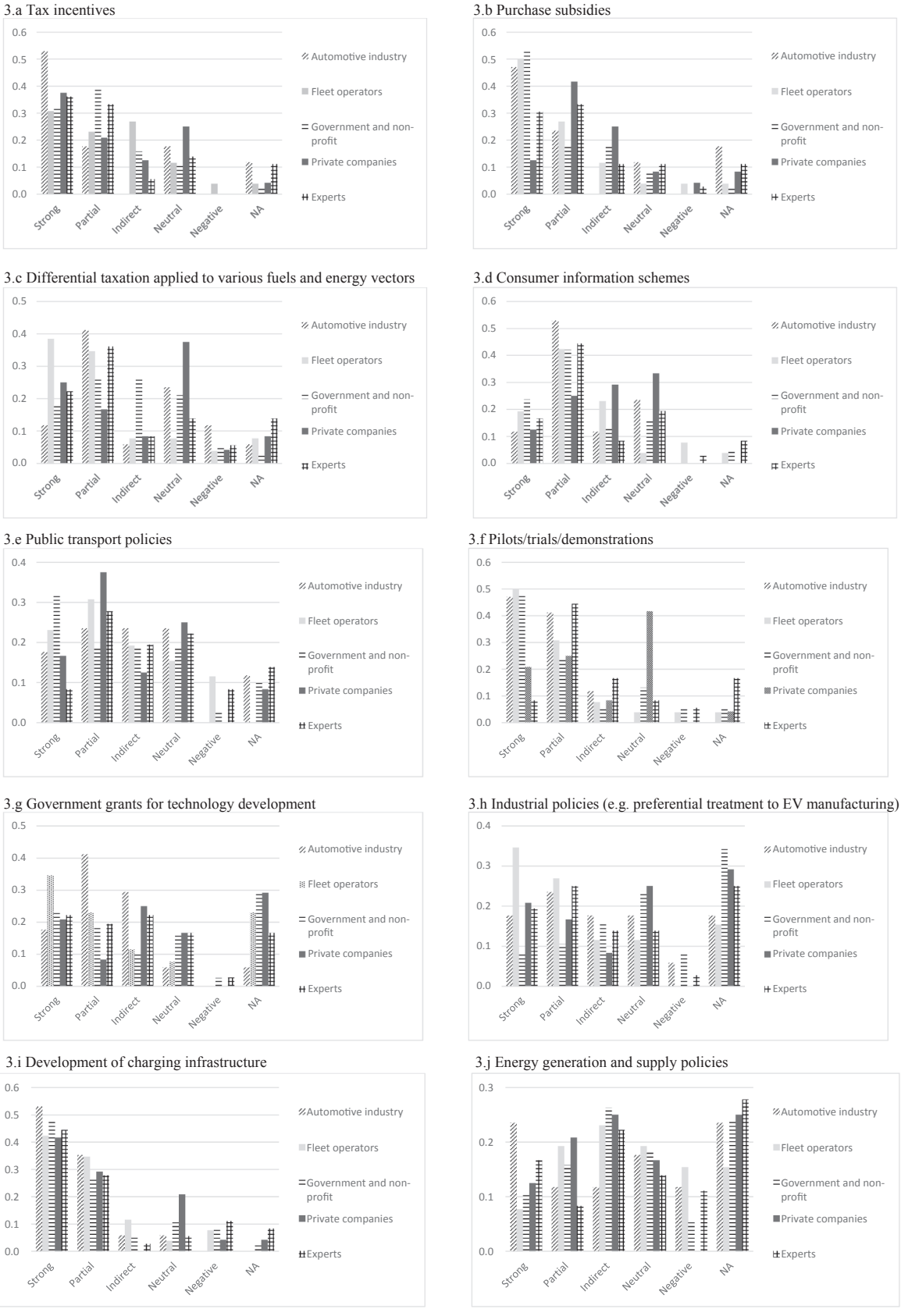


Fig. 3. Percentage of respondents by type of respondent and their assessment of each type of policy. Source: questionnaire responses.

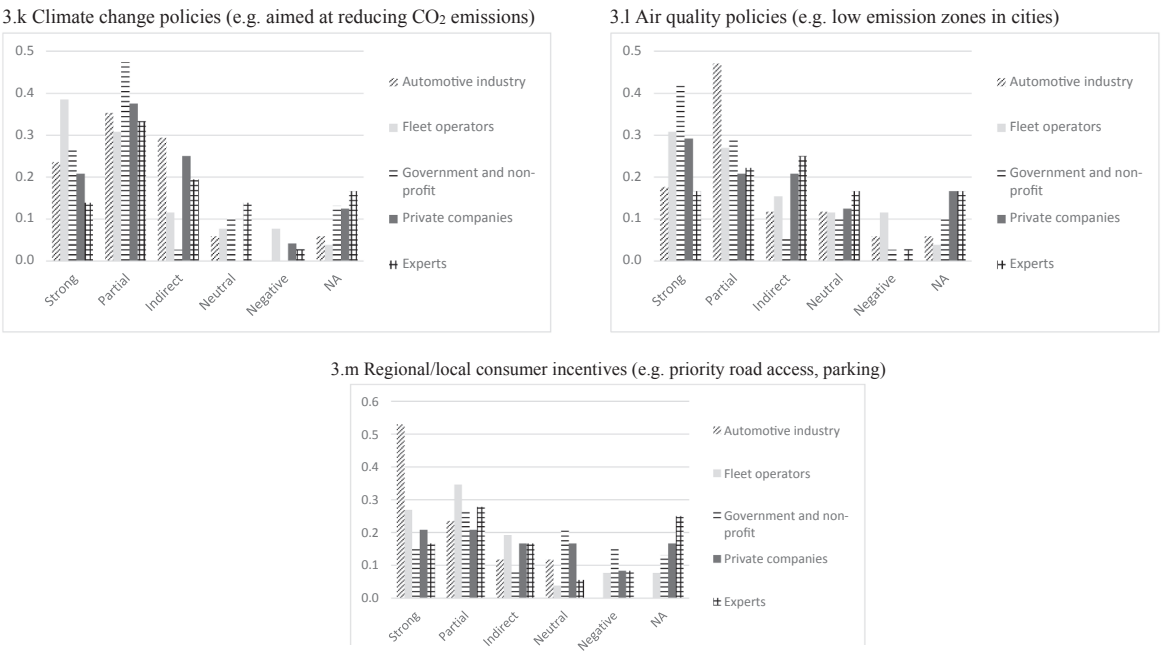


Fig. 3. (*continued*)

their justifications shows that either it was the absence of such incentive in their region, rather than the incentive itself, what had a negative impact, or that what they meant to say was that the incentive had no impact rather than a negative impact.

4.1. Tax incentives and purchase subsidies

As it can be seen in Figs. 2 and 3, tax incentives (panels 2.a and 3.a) and purchase subsidies (panels 2.b and 3.b) were perceived by most respondents as having a strong or partial positive influence on the uptake of EVs. Reading of the text justifying their scoring confirms that most respondents agree that tax incentives and purchase subsidies are important instruments that influence purchase decisions and increase EV uptake, with 65% and 68% of all 143 respondents, respectively, stating so, as shown in Table 4.

The Dutch respondents, for example, felt that a low company car tax for EVs was important. EV uptake in the Netherlands is, undoubtedly, very responsive to changes in this tax, as discussed in Section 2.

Reductions in circulation tax and company car tax for EVs are in place in Spain and most Spanish respondents agreed that tax incentives can reduce the total cost of ownership of EVs. The Spanish respondents, however, along with some German respondents, expressed concerns regarding the short-term characteristic of most government purchase subsidies, which tend to be in place only for a few years, in line with Wang et al. (2017), who cast the question on whether plans to progressively eliminate purchase subsidies in China will negatively impact the EV market. Norway, on the other hand, also plans to downsize its set of incentives, but this will probably have little, if any, impact on its EV share, which is high thanks to a well-developed market (Figenbaum, 2017). In 2016, for example, PHEVs and BEVs together represented 29% of all new passenger car registrations in that country (ACEA, 2017a,b), the highest in the world.

Not surprisingly, most of the respondents from the automotive industry (71%) and from government and charities (also 71%), regardless of the country where they were based, felt that tax incentives had a strong or at least a partial effect on EV uptake. This was also the case for purchase subsidies, an incentive that was strongly supported by fleet operators, with 77% of them stating that they had a strong or a partial positive impact.

Those stating that tax incentives and purchase subsidies had a neutral impact qualified their answers by stating that these were not high enough to trigger change in their regions. Three respondents from the automotive industry in Germany, for example, stated that:

"Tax incentives are too low to have an effect." (DE6)

"There are practically no tax incentives in the region. Thus until now they have had no influence on the uptake." (DE20)

"The amount of motor vehicle tax plays a secondary role in the total costs of operation." (DE27)

Just like the few respondents who thought that purchase subsidies were not influential, Bakker and Trip (2013, p. 19), find that purchase subsidies can be ineffective when EVs remain relatively expensive. Like the respondents in our study, Bakker and Trip (2013) also highlight that it all comes down to the amount of the subsidy. In addition, Bakker and Trip (2013) argue that car

manufacturers may not make an effort to lower costs and prices when there are subsidies. On the same lines, Lévay et al. (2017, p. 529), note that purchase subsidies can encourage 'gaming by manufacturers in their pricing policy', and give the concrete example of the Volkswagen e-up!, whose price without government subsidy was higher in the UK than in other European countries with lower or no subsidies.

In general, most respondents, from most countries and sectors, think that tax incentives and purchase subsidies are effective measures. These results are in line with findings by Lieven (2015), Bjerkan et al. (2016) and Lévay et al. (2017).[4] Sierzchula et al. (2014) also find a positive and significant relationship between financial incentives and EV adoption, although the relationship is weaker with lower financial incentives and varies greatly across countries with higher financial incentives.

Interestingly, Helveston et al. (2015, p. 110) conclude that American and Chinese consumers' willingness to pay for EVs is independent from the subsidies in place in the US and China, respectively, and Egbue et al. (2017, p. 1937) conclude that purchase subsidies and tax incentives can be an effective strategy for encouraging EV adoption during the early stages, but they argue that these financial incentives are not sustainable in the long run because they 'simply transfer money from taxpayers to EV buyers'.

Some of the British respondents caveated purchase subsidies in that they could send the wrong signal, as if there were something wrong with EVs and consumers had to be persuaded to buy them. This is actually in line with conclusions by Zhang et al. (2013, p. 391), who spell that idea out by clearly stating that 'subsidies provided by the government could be attractive only when they are large enough to compensate the relative disadvantage' of EVs' performance.

4.2. Differential taxation applied to various fuels and energy vectors

Differential taxation applied to various fuels and energy vectors (panels 2.c and 3.c) was perceived as having a positive impact by 53% of all 143 respondents. From the 16 Austrian respondents, 75% (including most experts as well as more than half of those working for government or non-profit organisations and one from the private sector) thought that differential taxation had a strong or at least a partial positive impact on EV uptake. Only four Austrian respondents thought that the impact was neither strong nor partial. According to them, differentiated fuel duties are not enough to persuade consumers, businesses and fleet operators to lean towards EVs, as they do not offset the difference in purchase costs, relative to conventional cars. According to an Austrian respondent from an NGO, for example, changing relative purchase prices would naturally be the first and most obvious instrument to tilt consumers' and businesses' purchasing decisions, and differential taxation on various fuels and energy vectors would complement policies on vehicle taxes and subsidies by changing the relative operating costs of EVs and conventional vehicles.

The Dutch respondents viewed fuel taxation as an important instrument to influence purchasing behavior, although due to the relative costs of fuel and electricity in that country, 20 out of 30 respondents stated that the impact was either indirect or neutral. The 20 respondents included five experts, one fleet operator, seven from private companies, and seven from government and non-profit organisations. These respondents felt that due to high taxation on electricity, total cost of ownership is still relatively high and therefore it does not favour electric mobility even though fossil fuels are heavily taxed in the Netherlands. In addition, they argued, the decrease in the pre-tax price of fossil fuels in the period 2013–2016 has acted as an incentive to stick to conventional vehicles. One of the Dutch experts, for example, stated that:

"Due to the lower fuel prices that we have seen in the last couple of years the total cost of ownership of an EV is not as attractive as it could be. Also the tax on fuel is currently not as high as the tax on electricity." (NL14)

Out of the 36 German respondents 23 thought that differential energy taxation can have a strong or partial positive impact on EV uptake. From the 13 respondents who did not think that differential taxation helps EV market penetration, some justified their responses by essentially stating that the differential was not large enough, thus implying that if the differential were large enough in Germany, it would have an impact. A respondent from the German automotive industry, for example, who stated that tax differentials had a neutral impact, justified this by saying:

"Vehicles with combustion engines are becoming more efficient, petrol price trends have gone down. Electricity for electric vehicles has become more and more expensive (due to the EEG levy)."[5] (DE10)

The explanation can be compared with that of a German civil servant who stated that the impact can be very strong:

"Fuel taxation accounts for a high proportion of the price of petrol. However, electricity for electric vehicles is also taxed depending on its primary energy source. In addition, the fluctuating and currently fairly low world market prices for crude oil keep the price of petrol low." (DE1)

Thus, two respondents from very different sectors, i.e., the automotive industry and government, provided very similar text showing their thoughts are on the same lines. One stated that differentials can have a positive impact and the other that they can have a positive impact but they do not due to the tax differential in Germany not being large enough.

Two respondents from Germany, both from the automotive industry, thought that differential taxation applied to various fuels and energy vectors had a negative impact on EV uptake. Once again, it becomes clear from their justifications that what they meant was that current taxation in Germany has a negative impact, and not that if fossil fuels had higher taxes relative to electricity, the impact on EV uptake would be negative:

[4] Lévay et al. (2017) conduct a detailed analysis of fiscal incentives and conclude that exemption from registration and circulation taxes in Norway and the Netherlands favours big EVs whereas lump-sum purchase subsidies in France and the UK favour small EVs.

[5] EEG stands for Erneuerbare-Energien-Gesetz, which can be transalted as Renewable Energy Sources Act, which is a series of laws to encourage the generation of renewable electricity.

"Fossil fuels are heavily taxed in Germany. Electricity is also highly taxed in Germany. Currently there is no cost advantage for consumers to purchase an electric vehicle even after taking into account any subsidies for the purchase of the vehicle. Electricity is so heavily taxed in Germany that the user will pay less to drive a diesel vehicle…" (DE20)

"Electricity is very expensive in Germany due to high taxes." (DE27)

Most British respondents (69%), on the other hand, stated that high taxation on petrol and diesel in comparison with electricity, which is not taxed as a fuel in the UK, provides a strong financial justification for purchasing an EV. The 31% of British respondents who did not think that differential taxation has a positive impact on EV uptake justified this be essentially saying that the differential should be larger. A civil servant from a local government agency, for example, stated that:

"Fuel taxes would need to be higher to drive significant uptake" (UK1)

Ten out of the 25 Spanish respondents (40%) also stated that tax differentials have or can have a positive impact. The 15 respondents who did not think so thought that fuel taxes in Spain were not high enough. One respondent from the automotive industry, for example, stated:

"Since the arrival of the first competitive electric vehicles in the market (around 2011), there haven't been any changes in the special tax on hydrocarbons, and the main variations in petrol and diesel prices have been due to fluctuations in the world price of oil. The increases have never been large enough to act as a clear incentive for buyers to consider purchasing an EV." (ES20)

If consumers are assumed to be rational and the tax differentials change the total costs of ownership, it would be reasonable to expect that these differentials would positively impact EV market penetration. However, it is not clear whether consumers analyse their operating costs in a systematic way in their vehicle or fuel purchases (Turrentine and Kurani, 2007). This brings us to a very interesting point evident in Fig. 3c. Out of the 26 fleet operators that responded to the questionnaire, 73% thought that differential taxation was an incentive that had or could have a strong or at least a partial impact on EV uptake. From all the different types of respondent, fleet operators are the (only) ones who are really likely to take into account total costs of ownership, including operating costs, over the life of a vehicle, in order to run their businesses, and this was reflected in their answers. This high percentage contrasts with 49% of all the other respondents, who also stated that fuel and electricity taxation differentials had a positive impact. This is an interesting finding, which supports to some extent, the idea that consumers do not always analyse vehicle operating costs in a systematic manner, in contrast with fleet operators, who do.

4.3. Consumer information schemes

Consumer information schemes (panels 2.d and 3.d) were seen by 58% of all 143 respondents as having a strong or at least a partial positive influence. The Dutch and Spanish respondents, for example, are convinced that consumers are not aware of the advantages of EVs, and some Austrian respondents think that consumers have a distorted understanding, mainly due to lack of adequate information. Similarly, the majority of German respondents believe that consumer information schemes are necessary to counterbalance the reluctant attitude towards a new technology. Furthermore, the majority of British respondents think that consumer information schemes are an important tool as they build confidence and reduce the fears in the minds of potential customers regarding a new technology. They believe that information campaigns such as 'Go Ultra Low' run by the UK Government in co-ordination with major automotive manufacturers, have a strong influence on people's attitudes.

Respondents from private companies were less likely to highlight consumer information campaigns as having a positive impact, with only 9 out of 24 (38%) stating so. The reasons were mixed. Whilst some respondents thought that public information campaigns did not have much influence because there were none or very few, others truly thought that information campaigns were not effective or needed. Examples of the former include a Dutch respondent, who stated that:

"There is not a lot of consumer information on electric vehicles." (NL23)

Examples of the latter include a British respondent, who stated that:

"For the average car buyer (who is not particularly interested in cars) most government and other EV information bypasses them." (UK34)

and a Dutch respondent, who thought that consumer information campaigns were not needed:

"This is not an issue; a potential buyer will search the information he needs." (NL20)

One point on which most respondents, regardless of the type of respondent and country where they were based, agreed, is that there is a lack of knowledge of EVs. This result is in line with findings by Bakker and Trip (2013, p. 20), who also find that many people are not familiar with EVs and the government may therefore have a role in providing accurate information. Andwari et al. (2017, p. 425) and Egbue et al. (2017, p. 1937) also recommend providing consumers with accurate information.

4.4. Public transport policies

Less than half of the study participants (47%) thought that public transport policies aimed at electrifying buses, taxis and cars used in car sharing schemes (panels 2.e and 3.e) had a strong or partial influence on the uptake of EVs.

From those who thought that there was a positive effect, most were of the opinion that having electric buses and taxis on the roads, would make electric mobility more visible, and this would in turn, influence purchasing behavior. Fleet operators, respondents from private companies, and respondents from government and non-profit organisations were particularly positive, as were German,

Austrian and Dutch respondents. A number of respondents highlighted the importance of integrating EVs with public transport in big cities, through car sharing schemes such as car2go,[6] which, they argued, in the case of Germany, Austria and the Netherlands, not only increased EVs visibility but also helped encourage the development of charging infrastructure. A German respondent from a private company explained:

"We have a project which combines e-vehicles and public transport so people get in contact with e-mobility." (DE33)

The Spanish and British respondents also thought that facilitating the purchase of electric taxis through grants and inclusion of electric buses in the public transport fleet could make electric mobility more visible and thus positively influence market penetration.

4.5. Pilots/trials/demonstrations

Pilots/trials/demonstrations (panels 2.f and 3.f) were perceived as having a positive impact by 66% of respondents. Not surprisingly, respondents from the automotive industry and fleet operators were the types of respondent most likely to think that pilot/trial/demonstrations have a positive influence, with 15 out of 17 automotive industry respondents (88%) and 21 out of 26 fleet operators (81%) stating so. Most of these respondents were based in Germany, so the share of German respondents thinking that pilot/trial/demonstrations had a positive effect was also the highest amongst the case study countries. Andwari et al. (2017, p. 425) also recommend 'high-visibility' trials as a way of familiarising potential car buyers with the technology.

4.6. Government grants for technology development

Government grants for technology development (panels 2.g and 3.g) were only perceived as having a positive influence (strong or partial) by 44% of respondents. This is surprising but it can be explained by a simple fact: government grants for technology development have not been abundant and therefore their effectiveness in the five case study countries is perceived as limited. Governments not doing more is puzzling to some extent, given that there are a number of technological hurdles that still need to be overcome, such as driving range (Andwari et al., 2017; Coffman et al., 2017, Egbue et al., 2017), charging time (Graham-Rowe et al., 2012; Andwari et al., 2017; Coffman et al., 2017) and battery size and weight (Andwari et al., 2017; Egbue et al., 2017). A cash injection from the government to support R&D could potentially help solve these problems quicker.

German respondents were more likely than others to indicate that government grants for R&D had a positive impact, with 25 out of 36 respondents (68%) stating so. This is not surprising given that 24 of the German respondents either came from the automotive industry or were fleet operators. These types of respondent were, understandably, more likely than the other types of respondent to perceive government grants for R&D as having a strong or at least partial positive influence. Ten out of 17 respondents from the automotive industry and 15 out of 26 fleet operators (58% and 59%, respectively) stated that government grants for R&D had a positive impact. A respondent from the automotive industry justified this by saying:

"Government grants are crucial to get technology on the road in a marketable form that consumers can access." (UK35)

A fleet operator stated that:

"Without funding, the projects would not be implemented." (DE5)

Unsurprisingly, Austrian and Dutch respondents were less likely than others to indicate that government grants for R&D had had a positive impact in their regions, and they justified that by indicating that the automotive industry in Austria and the Netherlands was not big. A civil servant from local government, for example, said:

"Subsidies for R&D have positive outcomes although they are limited for Austrian companies due to the vehicles being built elsewhere." (AT9)

Another respondent from an NGO argued that:

"Austria's car industry is just not important enough to be supported." (AT15)

A Dutch respondent from a private company stated:

"In the Netherlands we are not a large vehicle manufacturer. Most of the automotive related companies are in the supply chain of large Original Equipment Manufacturers outside the Netherlands. This is where the technological innovations come from." (NL5)

Only 9 out of 25 Spanish respondents (36%) stated that government grants for R&D had a positive impact, but this seems to be linked to the lack of grants, as stated by an automotive industry respondent:

"The strategic support to R&D of electro-mobility… allowed for the start of large projects in the period 2009-2010… Unfortunately, these grants for R&D were drastically cut in 2012, thus slowing down investment in these technologies, which led to a loss of competitiveness relative to other markets in which R&D has more support." (ES20)

An expert also said:

"Spain has an important automotive industry and R&D should play a key role in the future of electric vehicles." (ES22)

Although only 16 out of 36 British respondents (44%) indicated a strong or partial positive impact, their justifications reflect they believe these to be important. Many think that government grants for R&D are crucial for the promotion of EVs, and that the risk to businesses is very high in terms of investment and potential return due to the relatively small share of EVs in the market.

[6] Car2go is a car sharing company that operates in a number of cities in Asia, North America and Europe. Potential users register their details online, download an app, and then find a car2go car parked in the city using a live map on the app. They also use the app to start their car rental, they then drive to their destination and park their car2go car for free on any public parking lot within the car2go operating area. In a number of cities car2go cars are electric.

4.7. Industrial policies

Government policies directed at industry, such as for example, preferential treatment to EV manufacturing (panels 2.h and 3.h), were perceived to have a positive impact (strong or partial) by only 55 of the 143 respondents (38% of respondents). In Austria very few respondents thought industrial policies had an important impact in their region, which is not in any way surprising, given the relative size of the automotive industry in Austria.

In Germany, which has an important car manufacturing sector, 44% of respondents stated that industrial policies had had or could have a positive impact. Two German respondents, however, one from local government and one from the automotive industry, stated that the impact would be negative. Their concerns were that the automotive industry, which is still dominated by conventional fossil fuel vehicles, could be harmed if incentives to new alternative technologies in the form of preferential treatment to the manufacturing of EVs, were introduced too quickly.

Although 12 out of the 30 Dutch respondents (40%) stated that the influence of these policies had been positive, only one thought it had been strong with all the others suggesting it had been partial. The automotive industry in the Netherlands is part of a broader, cross-border automotive region which includes the Flanders region in Belgium and the North Rhine Westphalia region in Germany, so the result is not surprising.

Out of the 26 British respondents only 13 (36%) felt that industrial policies had a strong or a positive impact on EV uptake. Many respondents thought they had neutral or no impact. An expert, for example, stated that:

"There is general apathy and, in my view, it does not matter what the industrial policy is towards development of manufacturing capacity of EVs in a region; if consumers are not convinced of the benefits of acquiring an EV, then they will not purchase it." (UK7)

Another respondent from a private company said:

"Such policies have had negligible impact on how consumers trade off functional and symbolic benefits and costs of EVs and conventional cars – which is what determines uptake." (UK19)

On similar lines, only 10 out of 25 Spanish respondents (40%) indicated that industrial policies had a strong or partial influence on EV uptake, and some of the reasoning was like that from the British respondents. A respondent from a government agency, for example, argued that:

"All brands include electric vehicles in their catalogues already and their biggest difficulty is to sell them. The manufacturing capacity in Catalonia is not limiting…" (ES7)

4.8. Development of charging infrastructure

The development of charging infrastructure (panels 2.i and 3.i) was seen as extremely important, with 75% of respondents stating that a well-developed charging infrastructure would have a strong or at least partial, positive effect. This is an expected result, and certainly in line with previous research (Bakker and Trip, 2013; Sierzchula et al., 2014; Lieven, 2015; Bonges III and Lusk, 2016; Mersky et al., 2016; Egbue et al., 2017; Wang et al., 2017). If consumers and businesses, including fleet operators, cannot be assured of having reliable, compatible, and constantly accessible charging points, they will have reservations about purchasing EVs (Bonges III and Lusk, 2016). Coffman et al. (2017) also find a strong association between charging infrastructure and EV uptake, although they argue that the direction of causality is not clear. On similar lines, Harrison and Thiel (2017), conclude that charging infrastructure has a weak correlation with EV market penetration in the early stages, until the EV share is over 5%.

Reading of the free text for this incentive and generation of word clouds shows the ideas behind the respondents' reasoning. Fig. 4 shows the word clouds generated for this item,[7] using Nvivo 10, which we discuss in Section 3. The most prominent words in Fig. 4 are the ones that appeared more frequently in the text provided by the respondents on charging infrastructure.

Most of the respondents, from all five countries, stated that adequate, dense and visible charging infrastructure is vital for the uptake of EVs as it relieves drivers from range anxiety. When looking at responses by type of respondent, it is clear that there was not much variation. As could have been expected, however, respondents from the automotive industry were particularly emphatic, with 15 out of 17 (88%) stating that the development of charging infrastructure had a positive impact:

"Visible basic infrastructure is necessary to reduce range-anxiety." (DE21)

"Charging infrastructure enhances public visibility and reduces the short-range fear of EVs." (DE22)

"Although most EV drivers charge at home and at work most of the time, the investment in infrastructure is crucial for peace of mind in uptake of EVs." (UK35)

4.9. Energy generation and supply policies

Energy generation and supply policies (panels 2.j and 3.j) were not seen as having much of an influence, with only 28% of respondents stating that these would have a strong or partial effect. Importantly, there were no important variations across country where the respondent came from or type of respondent. Dutch respondents, however, thought they could have an indirect positive influence, with 40% of them stating so. They believe that a large percentage of the population is/would be willing to pay extra for green energy.

The problems linked to energy generation and supply entail two levels: one level is linked to energy sources (Helveston et al., 2015; Liu and Santos, 2015; Bjerkan et al., 2016; Mersky et al., 2016; Egbue et al., 2017), and the other level is linked to matching

[7] Word clouds were generated for all panels (2.a to 2.n) but are not shown here due to space constraints.

Germany

Austria

Spain

Netherlands

UK

Fig. 4. Word clouds for the question on development of charging infrastructure. Source: Questionnaire responses.

supply and demand (He et al., 2012), which in itself, could face additional challenges with an increase in the number of EVs on the roads (UK National Grid, 2017). The extent to which EV penetration will impact electricity networks will depend on the technologies and charging modes used (International Energy Agency, 2017, p. 41).

From the perspective of influence of policies in the area of energy generation and supply on the uptake of EVs, the energy mix can be an important driver. The respondents, quite reasonably stated that for EVs to be truly sustainable, they would need to use green electricity, in line with Helveston et al. (2015), Liu and Santos (2015), Bjerkan et al. (2016), Mersky et al. (2016) and Egbue et al. (2017).

In addition to the above, the German respondents thought that the high electricity cost in Germany acts as a deterrent to the advancement of EVs. They also argued that if the share of EVs were to increase substantially, electricity demand would exceed supply, and this would require additional funds for supply expansion, and in this case, regulatory measures would be needed for grid integration.

4.10. Climate change policies aimed at reducing CO_2 emissions

Unsurprisingly, climate change policies aimed at reducing CO_2 emissions (panels 2.k and 3.k) were perceived as having a strong or partial influence by most respondents, with 61% stating so. There were no important variations across country where the respondent came from or type of respondent. The idea behind most responses was simple: climate change policies encourage decarbonisation of the economy and decarbonisation in general necessitates decarbonisation of the transport sector. Most respondents from most countries, however, thought that climate change policy needs to be stronger in order to achieve the emissions reductions the different countries have committed to.

Two British civil servants from a local government agency, for example, stated that:

"More decarbonisation of the grid is needed." (UK1)

"The London Mayor's climate change (CO_2 emissions) targets and the proposed Ultra Low Emission Zone are designed to encourage the uptake of low carbon vehicles." (UK7)

A German respondent from the automotive industry said:

"The forthcoming CO_2 emission limits are the main lever for the introduction and commercialisation of these vehicles." (DE6)

and a German expert stated:

"CO_2 limits will not be reached after 2020 without e-mobility." (DE11)

A Spanish expert also agreed:

"Policies dealing with climate change do have a direct influence on EV uptake in our region, since electric mobility is necessary to reduce CO_2 emissions, which cause climate change." (ES23)

4.11. Air quality policies

Air quality policies (panels 2.l and 3.l), such as for example, low emission zones in cities, were seen as having a strong or at least a partial positive influence on EV uptake, with 56% of respondents stating so. There were no important variations across country where the respondent came from or type of respondent.

The Dutch respondents, for example, argued that policies in the area of air quality can have a positive influence on the uptake of EVs, in line with a number of British respondents, who thought that the Low Emission Zone and the 2020 Ultra Low Emission Zone will help drive EV technology and EV market penetration forward, although this will probably only impact the London region, rather than the whole of the UK. That said, there were some concerns regarding the public acceptability of zero emission zones in cities raised by some German, Spanish and Austrian respondents.

4.12. Regional/local consumer incentives

Other types of incentives, under the umbrella of regional or local incentives, such as priority road access or priority parking, were seen as having a strong or partial positive influence by 50% of respondents (panels 2.m and 3.m). These types of measures are not widespread and the experience is somewhat limited. Most respondents stating that the incentives had a positive impact came from areas where they were in place and most respondents stating that they had an indirect, neutral or even negative impact came from areas where these types of incentives were not in place.

Respondents from the automotive industry and fleet operators were the types of respondent most likely to think that priority road access and priority parking have a positive influence, with 13 out of 17 automotive industry respondents (76%) and 16 out of 26 fleet operators (62%) stating so. Most of these respondents are based in German regions where these policies are in place, and so it is likely that they welcome these measures based on the experience they have had with them rather than on any vested interests.

However, they also argued, use of bus lanes by EVs could have a negative impact on bus users, who might see their journey times increase, a concern that was also raised by the Austrian respondents, and by previous literature (e.g., Bakker and Trip, 2013; Bjerkan et al., 2016). There is some evidence that this may indeed be a side effect, especially if the electric vehicle fleet becomes large. Although access to dedicated bus lanes may have been important for EV adoption in Norway (Bjerkan et al., 2016), this incentive had to be removed in Oslo in 2015 due to EVs causing congestion and delaying buses (Figenbaum, 2017).

Dutch respondents, on the other hand, were less likely to show enthusiasm for local/regional incentives, with only 9 out of 30 (30%) indicating that this type of incentive had a strong or at least partial positive impact on EV uptake in the Netherlands. Those who did not think they had a positive impact explained that these incentives in the Netherlands were rare. Respondents from private companies, for example, stated that:

"There is a lack of incentives of this sort, and this has a negative effect on the uptake." (NL5)

"I think you have to promote electric vehicles by giving them free parking and allowing them to drive on taxi lanes." (NL20)

"These incentives can help, but we don't have any in our region." (NL23)

Although 14 out of the 25 Spanish respondents (56%) thought local incentives had a strong or at least a partial positive impact, many caveated their assessment. A respondent from a private company, for example, said that:

"In this initial phase of consolidation of the electric vehicle, especially in big cities, it is important to support those who have dared to become pioneers in the use of electric vehicles. Therefore, free parking, reduced tolls, access to bus or taxi lanes, free charging, etc. are essential policies to encourage the use of these vehicles. But these policies are not sustainable in time, as they have a significant economic impact and won't be sustainable once the use of electric vehicles becomes more popular." (ES9)

Out of 36 British respondents, 17 (47%) felt that incentives like exemption from the congestion charge in London and free/discounted parking with a guaranteed place, can have a strong influence for the advancement of EVs in London in comparison with other regions. They also stated that making dedicated bus lanes accessible to EVs would encourage penetration of EVs in the UK. However, Transport for London would not open dedicated bus lanes to EVs, as it considers this would decrease buses' speeds,[8] in line with the concerns aired by some of the German and Austrian respondents, and with what actually happened in Oslo, where access of EVs to bus lanes was removed in 2015 (Figenbaum, 2017).

Regional/local incentives are not widespread and as a consequence, only 50% of respondents thought they had had a positive impact on EV uptake in their region. Although they may not make total ownership costs break even with those from an internal combustion engine, they make EVs more attractive. This result is similar to findings by Langbroek et al. (2016), who find that the probability of stated EV adoption increases with free parking and access to dedicated bus lanes. Bakker and Trip (2013) also find that free parking for EVs in city centres can act as an incentive.

4.13. Differences and similarities in perceptions

The analysis above was conducted by country where the respondent was based and also by type of respondent. The idea was that respondents coming from different countries and different sectors could have different perceptions and motivations. This only proved to be the case for some, not all, of the incentives and policies considered. The incentives for which differences of opinion by country or sector were identified were Differential taxation applied to various fuels and energy vectors, Consumer information schemes, Pilot/trial/demonstrations, Government grants for technology development and Regional/local consumer incentives. These differences are summarised below.

Differential taxation applied to various fuels and energy vectors: Fleet operators were the group with the largest share of respondents stating that differential taxation on fossil fuels and electricity had a positive effect on EV uptake. This can be explained by the fact that this group of respondents is the group that needs to take into account total costs of ownership, including operating costs, over the life of a vehicle, in order to make decisions on their fleet composition and make their business profitable. This is not only a very interesting finding but it also supports previous suspicions that consumers do not analyse costs over the life of the vehicle they will buy in a systematic manner, in contrast with fleet operators, who do, as their businesses would not survive if they did not.

Consumer information schemes: Respondents from private companies, excluding car manufacturers and fleet operators, were less likely to perceive consumer information campaigns as having a positive impact and the reasons for this were mixed. Some respondents thought that public information campaigns did not have much influence because there were none or very few, whilst others thought that information campaigns were neither effective nor necessary.

Pilot/trial/demonstrations and Government grants for technology development: Respondents from the automotive industry and fleet operators were the types of respondent most likely to think that Pilot/trial/demonstrations and Government grants for technology development had a positive influence on EV uptake. This is not surprising given their vested interests. Most of these respondents were based in Germany so this increased the share of German respondents perceiving these policies as having a positive impact.

Regional/local consumer incentives: Germany has a number of priority road access and priority parking policies for EVs in place and a positive experience of these clearly swayed German respondents' answers, who were the group most likely to think that these incentives had a positive impact on EV uptake. Most of the respondents from the automotive industry and fleet operators were from Germany so although unlikely, it is also possible, that it was not due to the German experience but due to the sector they worked in that they thought that this type of consumer incentive had a positive impact on EV uptake.

It should be emphasised that there were no important differences in perception regarding the rest of the policies and incentives considered in this study. This is a novel and original finding, as it could have been expected that respondents from different sectors or countries would have felt differently about some of them, considering their experiences and motivations.

5. Conclusions and policy recommendations

On the basis of 143 responses from experts and stakeholders from Germany, Austria, Spain, the Netherlands and the UK collected between March 2015 and July 2016 we identify the incentives that most respondents thought were important for the uptake of EVs. Respondents were asked to reflect on the impact of these incentives in their own regions. In many cases these incentives were not in place. When this was the case, some respondents chose to say that they had had no impact because the incentive had not been

[8] Private communication with Transport for London.

implemented, whereas others chose to say that they would have an impact if they were implemented. Due to the difference in approach taken by different respondents, some conclusions may underestimate the percentage of respondents who actually thought the incentive would have a positive impact if it were implemented. With that caveat in mind, we conclude that the four incentives that emerged as winners in this study are the development of charging infrastructure, purchase subsidies, pilot/trial/demonstrations and tax incentives.

Surprisingly, and this is a new finding, perceptions did not substantially differ across countries where the respondents were based or sectors the respondents worked in. The exceptions were fleet operators, which had a very large share of respondents stating that differential taxation applied to various fuels and energy vectors had a positive impact; private companies, which had a small share of respondents stating that consumer information schemes had a positive impact; car manufacturers along with fleet operators, which were groups with a large share of respondents stating that both pilot/trial/demonstrations and government grants for technology development had a positive impact, and German respondents, who felt that priority road access and priority parking policies for EVs were important.

Excluding the cases highlighted above, there were no important differences in opinion across countries or sectors. The one incentive that most respondents thought would help EV uptake, with 75% stating so, was the development of charging infrastructure. Three other incentives were also seen as very important by more than half of respondents: 68% thought that purchase subsidies had a positive impact; 66% thought that pilot/trial/demonstrations had a positive impact; and 65% thought that tax incentives had a positive impact.

Other incentives that were also perceived to have a positive impact by more than half of the respondents were climate change and air quality policies, consumer information campaigns, and differential taxation applied to various fuels and energy vectors.

The obvious policy recommendation that can be derived from the research conducted in this study is that any government wanting to increase EV uptake needs to develop or help develop/support EV charging infrastructure to ease range anxiety. This seems to be an essential measure without which EV uptake will be too slow. Other policies that appear to be necessary, if not crucial, include purchase subsidies, pilot/trial/demonstrations and tax incentives.

Importantly, these recommendations apply to all the five countries we studied and may indeed apply to countries with similar technological challenges, consumer and business perceptions and relative costs. Local idiosyncrasies, local automotive industry, national fuel and electricity taxation, may, of course, influence the magnitude and reach of these policies but all four types of incentives are perceived as important, regardless of national circumstances.

Given the NDCs pledged by the different countries under the Paris Agreement, the time to decarbonise the economy is running out. Action needs to be taken and this needs policies to reduce CO_2 emissions from road transport. EVs offer an excellent solution but their uptake needs to be accelerated. The four incentives most experts and stakeholders in our five case study countries agree will help increase EV market penetration, charging infrastructure, purchase subsidies, pilot/trial/demonstrations and tax incentives, can be implemented easily and relatively quickly in most countries in Europe and potentially throughout the world, provided the necessary public funds can be allocated to this purpose.

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Appendix A. Supplementary material

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